Europäisches Patentamt
European Patent Office
Office européen des brevets

(19)

(11) Publication number: **0 624 870 A2**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **94202146.0**

(51) Int. Cl.[5]: **G11B 7/26**

(22) Date of filing: **21.03.90**

This application was filed on 22 - 07 - 1994 as a divisional application to the application mentioned under INID code 60.

(30) Priority: **27.03.89 JP 75731/89**
25.07.89 JP 193547/89
24.10.89 JP 277511/89
22.01.90 JP 12834/90
14.07.89 JP 183215/89

(43) Date of publication of application:
17.11.94 Bulletin 94/46

(60) Publication number of the earlier application in accordance with Art.76 EPC: **0 390 413**

(84) Designated Contracting States:
DE FR GB NL

(71) Applicant: **MITSUBISHI DENKI KABUSHIKI KAISHA**
2-3, Marunouchi 2-chome
Chiyoda-ku
Tokyo (JP)

(72) Inventor: **Toide, Yukari, c/o Mitsubishi Denki K. K.**
Zairyo Kenkyusho,
1-1 Tsukaguchi-Honmachi 8-chome
Amagasaki-shi (JP)
Inventor: **Tsutsumi, Kazuhiko, c/o Mitsubishi Denki K. K.**
Zairyo Kenkyusho,
1-1 Tsukaguchi-Honmachi 8-chome
Amagasaki-shi (JP)
Inventor: **Taguchi, Motohisa, c/o Mitsubishi Denki K. K.**
Zairyo Kenkyusho,
1-1 Tsukaguchi-Honmachi 8-chome
Amagasaki-shi (JP)
Inventor: **Tsuchihashi, Masaru, c/o Mitsubishi Denki K. K.**
Sangyo System Kenyusho, 1-1
Tsukaguchi-Honmachi
8-chome, Amagasaki-shi (JP)

(74) Representative: **Dawson, Elizabeth Ann et al**
A.A. THORNTON & CO.
Northumberland House
303-306 High Holborn
London WC1V 7LE (GB)

(54) **Apparatus for making optical discs.**

(57) Apparatus for making optical discs, of the type comprising two disc units (201,202), bonded together with adhesive (32), comprises a centre shaft (31) supporting the two units and means (63,64) for holding a point on the edge of one unit (202) so that the one unit is tilted relative to the other. The holding means (63,64) can be lowered to bring the surfaces of the two units into contact.

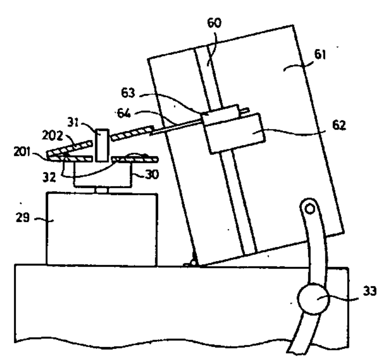


FIG. 6

EP 0 624 870 A2

BEST AVAILABLE COPY

This invention relates to apparatus for manufacturing an optical disc, such as an erasable optical disc, which may be used as, for example, an external device of computers.

BACKGROUND OF THE INVENTION

Figure 1 shows a cross-section of an ordinary optical disc, designated as 10. A recording layer 2 is formed on a transparent substrate 1 of resin, such as, for example, polycarbonate, and a protective film 3 is formed over the recording layer 2. The substrate 1, the layer 2 and the film 3 form a disc unit 4. Two such disc units 4 are bonded to each other at the exposed surfaces of the respective protective films 3 with an adhesive layer 5. Thus, the optical disc 10 is formed. Conventionally, in order to bond the disc units 4 together, a thermosetting adhesive, an ultraviolet-curable adhesive, or a thermoplastic adhesive has been used. A corrosive component contained in such adhesives, however, tends to degrade the recording layers 2, and, in particular, when the water absorption of the adhesive layer 5 is high, the protective films 3 and the recording layers 2 are oxidized, which lowers the reliability of the disc 10. A moisture-curing adhesive, such as one-pack epoxy resin adhesive, may be used. However, when disc units having large areas are bonded with a thin layer of a moisture-curing adhesive, air or moisture hardly penetrates to reach center portions of the bonded disc units, resulting in incomplete curing of the adhesive. Furthermore, bonding disc units with such an adhesive requires a long time and also is a difficult working. When two-pack non-mixing type resins and microcapsule type resins are used, some components may remain uncured, which will erode the discs. Furthermore, such adhesives can provide insufficient adhesion. For such reasons, two-pack non-mixing type and microcapsule type adhesives are considered unsuitable for bonding disc units.

Another problem which may be encountered when curing type adhesives are used is that contraction of the curing adhesive may cause distortion of the disc units. In particular, when a thermosetting adhesive is used, not only contraction of the adhesive occurring when it cures but also heat applied for causing the adhesive to cure will distort the adhesive layer 5 itself. Distortion of the adhesive layer 5 causes deformation or warpage of the disc units, and, therefore, resulting optical discs may have to be rejected.

The use of a thermoplastic resin adhesive rather than a thermosetting resin as the adhesive layer 5 is disclosed in, for example, Japanese Patent Publication No. SHO 63-67258. In the invention disclosed in this patent publication, a hot-melt type adhesive, which is thermoplastic, is used for the adhesive layer 5. A hot-melt adhesive which has been heated and melted is applied over the protective film 3 of a first disc unit 4. Then, the other disc unit 4 is placed on the first disc unit 4 in such a manner that the protective film 3 of the other disc unit 4 comes into contact with the adhesive which has been applied over the protective film 3 of the said first disc unit 4. Then, the assembly is cooled to room temperature so that the hot-melt adhesive cures to bond the two disc units 4 to each other.

Since such a thermoplastic resin adhesive need not be heated for its curing, distortion of the adhesive layer 5 is small, which, in turn, can advantageously reduce warpage of the disc units 4. However, if the adhesive is applied non-uniformly, portions of the adhesive layer 5 may be swelled due to moisture which penetrates into it through the substrate 1, and the disc units may be cracked or may be separated from each other.

Usually, optical discs are used under various environments, from cold districts to hot districts, and, accordingly, the temperature at which discs are designed to be able to perform desired functions (hereinafter the temperature being referred to as usable environment temperature) is required to range, for example, from -20°C to 60°C. The inventors have conducted humidity-resistance tests and temperature-humidity cycle tests on optical discs comprising two disc units 4 bonded together with a hot-melt adhesive at the above-stated temperature range of from -20°C to 60°C at which discs may be used. They found that the recording layers 2 were readily peeled off, pin holes were produced and, when the number of test cycles increased, bit error rates increased abruptly. Therefore they concluded that such optical discs were not sufficiently reliable.

One conventional technique for bonding two disc units 4 together is as follows. A first disc unit 4 is positioned with the recording layer 2 facing upward. An adhesive is applied over the protective film 3 on the recording layer 2 in generally concentric circles. A second disc unit 4 is aligned with the first disc by means of a center shaft of a disc manufacturing apparatus, and the protective film 3 of the second disc unit is brought into contact with the adhesive. The resultant assembly is left as it is so that the the adhesive is spread over the entire surfaces of the protective films due to the weight of the disc unit, and the adhesive is caused to cure to bond the two disc units together. In this bonding technique, bubbles may be disadvantageously formed in the adhesive when it is applied over the protective film or when the second disc unit is brought into contact with the adhesive on the protective film of the first disc unit, and the bubbles may remain after the adhesive cures.

One method for preventing such bubbles from being formed in the adhesive layer is shown in Japanese Unexamined Patent Publication No. SHO 61-50231. According to the method shown in this patent publication, an adhesive is applied over the entire surface of the protective film 3 by spin-coating, and the two disc units are bonded together with their center axes aligned with each other. According to another method which is shown in Japanese Unexamined Patent Publication No. SHO 61-292244, an adhesive is applied over portions of the protective film 3 of one disc unit, the other disc unit is placed over the first disc unit with the center axes of the two disc units aligned, and pressure is applied to bond the two disc units together with the adhesive spread over the entire surfaces of the protective films.

When an adhesive is applied over the entire surface of the protective film 3 of one disc unit 4 and the other disc unit is bonded to the first disc unit, the adhesive may forced out into the center holes of the disc units and also around the bonded disc units, and, when the adhesive cures, burrs 7 may be formed on the periphery of the center hole 6 of the optical disc 10 and on the periphery of the disc 10, as shown in Figures 2(a) and 2(b). Burrs 7 formed within the center hole 6 could make the disc 10 eccentric, and, accordingly, they should be completely removed. In order to deburr, a deburring device, such as one shown in Japanese Unexamined Patent Publication No. SHO 61-80534, may be used. However, the use of a deburring device will undesirably increase the number of manufacturing steps, which, in turn, increases the manufacturing costs. On the other hand, even when the adhesive is applied over portions of the protective film, it may be forced out or ooze out as in the case when the adhesive is applied over the entire surface as stated above, or, sometimes, the distribution of the adhesive may be non-uniform, so that the disc 10 may flutter.

In order to prevent the adhesive from oozing out into the center hole or out of the periphery of the disc, a precisely adjusted pressure must be applied, which requires high-precision, expensive equipment. One of the most simple techniques for bonding two disc units is the use of the weight of a disc unit itself with an adhesive placed between the two disc units. In this technique, however, if an adhesive having viscosity of less than 100 cps is used, it may ooze out and form burrs 7 like the ones shown in Figures 2(a) and 2(b). In contrast, if the viscosity of the adhesive is above 1000 cps, the adhesive may not spread over the entire space between the two disc units 4, as shown in Figures 3(a) and 3(b). Even if the amount of the adhesive to be applied is precisely measured, oozing out of the adhesive as shown in Figures 2(a) and 2(b) or absence of the adhesive at some portions as shown in Figures 3(a) and 3(b) may occur if the adhesive is applied to disc units at inappropriate positions.

A reduced-pressure bonding apparatus as shown in Figure 4 has been conventionally used for bonding, with an adhesive, two disc units without leaving bubbles in the adhesive layer. In Figure 4, a vacuum chamber 11 houses mounts 14 and 15 coupled respectively to shafts 12 and 13 which can move up and down. Disc units 4 with adhesive layers 16 and 17 applied over the surfaces of protective films 3 of the respective disc units 4 are mounted on the mounts 14 and 15, respectively. A vacuum pump (not shown) is operated to reduce the pressure in the vacuum chamber 11 through an exhaust pipe 18 to a pressure of about 20 Torr or less. Then, the shafts 12 and 13 are moved so as to move the mounts 12 and 13 toward each other for bonding the disc units 4 together. The adhesive may be cured under a reduced pressure or under normal pressure, but the pressure under which the bonding of disc units is carried out must be about 20 Torr or below. When the pressure is higher than that, bubbles may be formed in the adhesive.

When the reduced-pressure bonding apparatus of Figure 4 is used, the adhesive is applied at least portions of the protective films 3 of the disc units 4, and the disc units 4 are bonded with the adhesive which is spread over the entire surfaces of the films 3 due to application of pressure. It is, therefore, necessary to control precisely the movement of the shafts 12 and 13 in order to prevent the adhesive from oozing out into the center hole or to the outer periphery of the disc or from being non-uniformly distributed. Furthermore, it is necessary to determine precisely the amount of adhesive to be applied and also the position where the adhesive is to be applied. In addition, it is also necessary to maintain the pressure in the reduced-pressure bonding apparatus at about 20 Torr or below. If one wants to use this type of apparatus for mass-production of optical discs, the apparatus must be considerably large in size.

An object of this invention is to provide apparatus for use in manufacturing optical discs, according to which, when two disc units are bonded together with an adhesive, the adhesive does not ooze out into the center hole or to the outer periphery of a resulting disc, and, accordingly, a step for removing burrs can be eliminated. The resulting optical discs are free of eccentricity and free of surface fluttering.

The apparatus for manufacturing an optical disc according to the present invention, comprises a centre shaft, mounted on a support, for supporting two disc units; holding means for holding one point on the outer periphery of one of the two disc

units supported by said centre shaft so that said one of the two disc units slants relative to the other one of the two disc units; driving means for supporting said holding means, said driving means being movable up and down at an adjustable speed; and angle adjusting means; for adjusting the slanting angle of said driving means in order to vary the slanting angle of said one disc unit.

Embodiments of the invention will now be described in detail by way of example only with reference to the accompanying drawing in which:

FIGURE 1 is a cross-sectional view of a portion of a common optical disc;

FIGURES 2(a) and 2(b) are plan and cross-sectional views, respectively, of an optical disc comprising two disc units bonded with a low-viscosity adhesive according to a conventional technique;

FIGURES 3(a) and 3(b) are plan and cross-sectional views, respectively, of an optical disc comprising two disc units bonded with a high-viscosity adhesive according to a conventional technique;

FIGURE 4 is a cross-sectional view of a conventional reduced-pressure bonding apparatus for bonding two disc units;

FIGURE 5 is a cross-sectional view of a portion of a novel optical disc;

FIGURE 6 shows schematically the structure of a first example of apparatus suitable for manufacturing optical discs according to the present invention;

FIGURE 7 shows changes, with time, in C/N ratio and bit error rate of optical discs comprising two disc units bonded together, which can be indexes of operation reliability of discs; and

FIGURE 8 shows another example of apparatus of the present invention which may be used to manufacture optical discs.

Now, the present invention is described in detail with reference to the accompanying drawings.

As shown in Figure 5, an optical disc may be manufactured in the following manner. A layer 22 of dielectric material, such as silicon nitride (SiN_x), is formed over a surface, in which grooves may be formed, of a transparent substrate 21 of synthetic resin, such as polycarbonate, having a glass transition temperature of, for example, 130°C. Then, over this dielectric layer 22, a recording layer 23 is formed. The recording layer 23 may comprise an amorphous magnetic material having perpendicular magnetic anisotropy, such as terbium-iron-cobalt (Tb-Fe-Co). A protective film 24 of, for example, silicon nitride (SiN_x) is formed over the recording layer 23 to complete a disc unit 20. Two such disc units 20 are bonded together, with their respective protective films 24 facing each other, with an adhesive layer 25 interposed between them. The basic structure of this optical disc is substantially the same as that of conventional ones. The optical disc of Figure 5 is characterised by the material of the adhesive layer 25.

The adhesive layer 25 comprises a thermosetting adhesive which has a glass transition temperature higher than the upper limit of the usable environment temperature range of, for example from -20°C to 60°C, of the disc, and which can cure at room temperature. An example of adhesive usable in the present invention is a tow-pack room-temperature curable epoxy adhesive which comprises a bisphenol epoxy resin, as a base, and a modified aliphatic polyamine, as a curing agent, has a viscosity of from 100 to 1000 cps, and has a pot life of one hour or longer. This adhesive can cure at room temperature and has a glass transition temperature of about 70°C, and, therefore, it can satisfy the above-described conditions. The above-described two-pack epoxy adhesive has to have a cure shrinkage of 1.0% or less, a water absorption of 0.2% or less, and a Shore hardness of from 80 to 90 (D scale), after it cures.

Another example of usable adhesive is a two-pack room-temperature curable epoxy adhesive which comprises a bisphenol epoxy resin, as its base, and a modified aliphatic polyamine, as the curing agent, having a viscosity of 100 cps or less at room temperature. This adhesive has a viscosity of 100-1000 cps and a pot life of one hour or longer, and can be cured at room temperature. Like the first described example, this adhesive should have a cure shrinkage of 1.0% or less, a water absorption of 0.2% or less, and a Shore hardness of 80-90 (D scale).

Bisphenol epoxy resins usable as the base agent of the adhesives are a bisphenol A epoxy resin (commercially available as TB2022 (trade name) from Three Bond Co., Ltd. Hachioji-shi, Tokyo, Japan), and a bisphenol F epoxy resin (commercially available as TB2023 from Three Bond Co., Ltd.). Experiments have revealed that two-pack epoxy adhesives other than the above-described ones and one-pack epoxy adhesives cause the recording layers to be oxidised and degraded due to corrosive components contained in such adhesives.

In some applications, adhesives to be used for manufacturing optical discs may be selected from the viewpoint of glass transition temperature and warpage of substrates or disc units.

An embodiment of apparatus according to the invention will now be described.

As shown in Figure 6, in a normal pressure environment, one of highly corrosion-resistant, Tb-Fe-Co disc unit 201 having a diameter of, for example, 130 mm was placed horizontally on a support 30 secured to a center shaft 31 which

extended from a base 29, with the center hole in the disc unit 201 being fitted over the shaft 31. 0.5 g of adhesive was applied in a circle having a radius of 40 mm on the disc unit 201. This quantity of the adhesive was to provide a thickness of from 20 to 70 microns of the adhesive layer when it cured. Then, the second disc unit 202 to be bonded to the first disc unit 201 was fitted over the center shaft 31, and only one point on the peripheral edge of the second disc unit 202 was brought into contact with one point on the periphery of the first disc unit 201. Thus, the second disc unit 202 was held slanting relative to the first unit 201. Preferably, the adhesive is applied along the circumference of a circle having a radius of from 0.5a to 0.85a from the center of the disc unit 201, where a is the radius of the disc unit 201. In the example being discussed, the adhesive was applied along the circumference of a circle having a radius of about 0.6a from the center.

A holding mechanism for the second disc unit 202 comprises a base 61 of which the slanting angle is adjusted by angle adjusting means 33, a shaft 60 attached to the base 61, drive means 62 movable up and down along the shaft 60, holding means 63 held by the driving means 62, and an extension 64 extending from the holding means 63. The slanting angle of the base 61 is adjusted so that the shaft 60 becomes substantially parallel with the line which connects points on the peripheral edges of the first and second disc units 201, 202 diametrically opposite to the aforementioned points which are in contact with each other. The tip end of the extension 64 is in engagement with the aforementioned diametrically opposite point on the outer periphery of the second disc 202 to hold the unit 202 slanted as shown. The drive means 62 is then lowered along the shaft 60 at a rate of, for example, about 1 mm/sec. so as to slowly place the second disc unit 202 on the first disc unit 201. When the second disc unit 202 has been lowered, the tip end of the extension 64 is still in engagement with the second disc unit 202, although the engagement is slight. Then, the holding means 63 is actuated to retract the extension 64 to disengage from the second disc unit 202. Then, the weight of the disc unit 202 causes the adhesive to spread over the entire space between the two disc units 201 and 202, while causing no oozing of the adhesive from the inner periphery of the center hole or from the outer periphery of the disc and also leaving no portions uncoated with the adhesive.

The disc was left at room temperature for 24 hours to cure the adhesive. The maximum tilt angle of the disc measured was 0.9 mrad, and the maximum amount of increase of the birefringence was 2.1 nm. These values show that the disc is satisfactory. This disc was left in a 60 °C, 90% RH atmosphere for 3,000 hours to see how much the disc was corroded. Figure 7 shows the results. Because of no corrosion produced, the C/N (carrier/noise) ratio did not decrease, or the B.E.R. (bit error rate) did not increase. This means that the optical disc is highly reliable.

Further, the disc was subjected to severe temperature/ humidity cyclic tests to determine how the protective films and the recording layers were hardly peeled off. Even after the disc was subjected to 30 cycles of the tests, no swell was formed, neither the protective films nor the recording layers peeled off, and neither the C/N nor the B.E.R. changed.

For manufacturing optical discs, an apparatus as shown in Figure 8 may be used, too. In Figure 8, a base 29, a center shaft 31 for supporting disc units 201,202, and a support 30 are similar to the corresponding components shown in Figure 6, and the position on the disc unit 201 where the adhesive is to be applied is same as in Figure 6. In the apparatus of Figure 8, rotation means 42 is mounted on vertical drive means 41. An arm 44 pivots about a pivot 43 on the rotation means 42. Holding means, such as suction means, 45 is attached to the tip end of the arm 44 to hold the disc unit 202 slanting as shown.

Under a normal pressure condition, the first disc unit 201 having a diameter of, for example, 130 mm is placed horizontal on the support 30 with the center shaft 31 extending through the center hole in the disc unit 201. then, 0.5 g of the adhesive 32 is applied onto the disc unit 201 along the circumference of a circle having a diameter of about 40 mm. The second disc unit 202 is then placed in the apparatus, with the center shaft 31 extending through the center hole of the disc unit 202. In this case, one point on the outer periphery of the disc unit 202 is brought into contact with the corresponding point of the first disc unit 201. The second disc unit 202 is held by the suction means 45 at the portion diametrically opposite to that one point. Thus, the second disc unit 202 is held slanting as shown. In this case, the vertical position of the drive means 41 and the angle of the arm 44 are so adjusted that the arm 44 is in parallel with the surface of the second disc unit 202.

Then, the rotation means 42 is activated so as to cause the arm 44 to pivot in such a manner that the tip end of the arm 44 is lowered at a rate of, for example, 1 mm/sec. Thus, the second disc unit 202 is placed on the first disc unit 201. Seeing that the adhesive is spread over the entire space between the two disc units by the weight of the second disc unit 202, the adhesive 32 is cured at room temperature. In place of the illustrated jack-type device, any other types of drive means 41 can be used.

Claims

1. Apparatus for manufacturing an optical disc, comprising a centre shaft (31), mounted on a support (30), for supporting two disc units (201,202); holding means (63; 44,45) for holding one point on the outer periphery of one of the two disc units (202) supported by said centre shaft (31) so that said one of the two disc units slants relative to the other one of the two disc units (201); driving means (62; 41) for supporting said holding means, said driving means being movable up and down at an adjustable speed; and angle adjusting means (33; 42,43) for adjusting the slanting angle of said driving means (62; 41) in order to vary the slanting angle of said one disc unit.

2. Apparatus as claimed in claim 1 in which the driving means is mounted on a shaft (60) whose inclination relative to the centre shaft (31) is adjustable by said angle adjusting means.

3. Apparatus as claimed in claim 1 or 2 in which the holding means includes an extension (64) extending from the shaft (60) to support said point on said one of the two disc units (202).

4. Apparatus as claimed in claim 3 in which the holding means (63) is actuable to retract the extension (64).

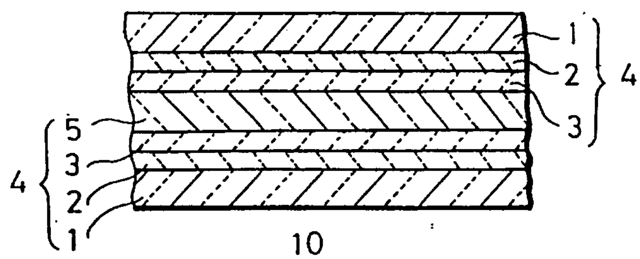
5. Apparatus as claimed in claim 1 in which the holding means comprises an arm (44) having means (45) at one end for holding said point on said one disc unit (202).

6. Apparatus as claimed in claim 5 in which the holding means (44,45) holds the disc unit from above.

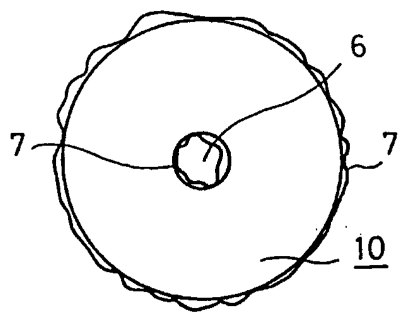
7. Apparatus as claimed in claim 5 or 6 in which the means (45) at one end of the arm (44) holds the disc unit by suction.

8. Apparatus as claimed in claim 5,6 or 7, in which the angle adjusting means comprises rotation means (42) mounted on the drive means for rotating the arm about a pivot point (43) whereby to adjust the angle of the drive means relative to the arm and the one disc unit (202).

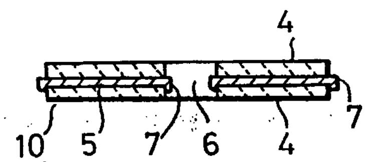
9. Apparatus as claimed in claim 5,6,7 or 8 in which the drive means has the form of a jack.



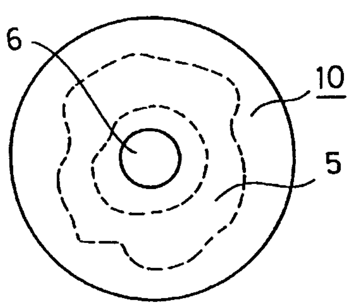
F I G . 1



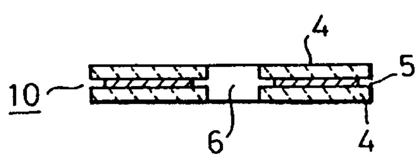
F I G 2(a)



F I G 2 (b)



F I G 3(a)



F I G 3(b)

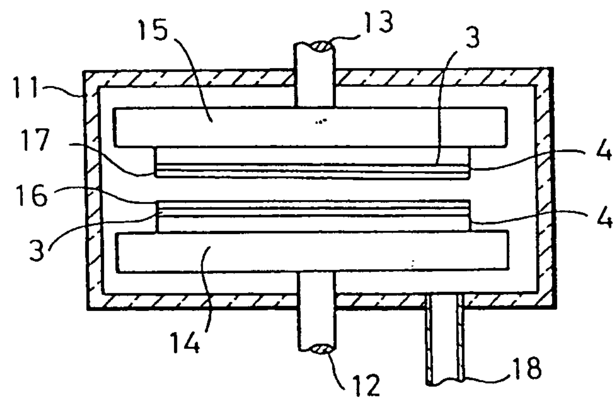


FIG. 4

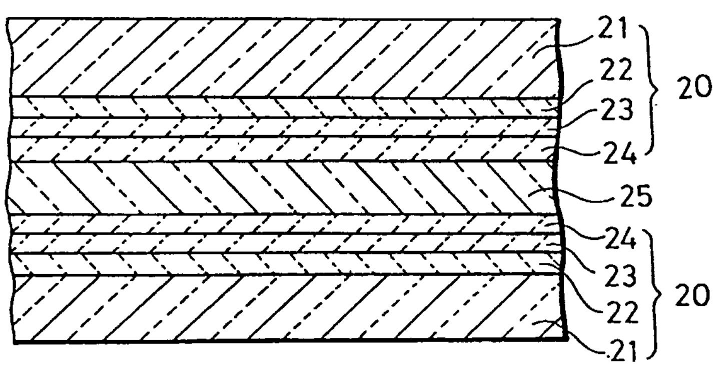


FIG. 5

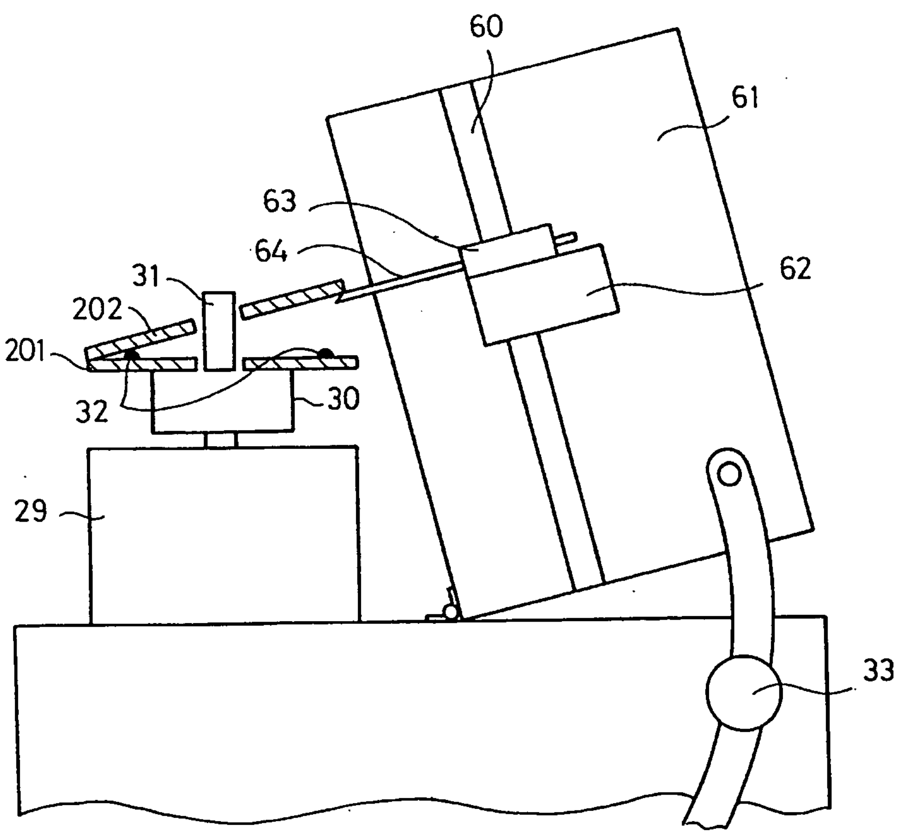


FIG. 6

BEST AVAILABLE COPY

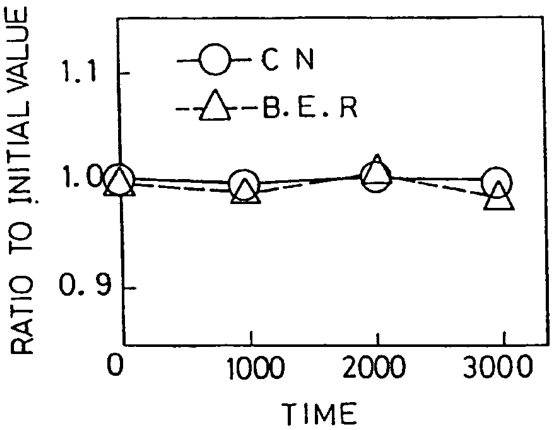

RATIO TO INITIAL VALUE
1.1
1.0
0.9
0
1000
2000
3000
TIME
C N
B.E.R

FIG. 7

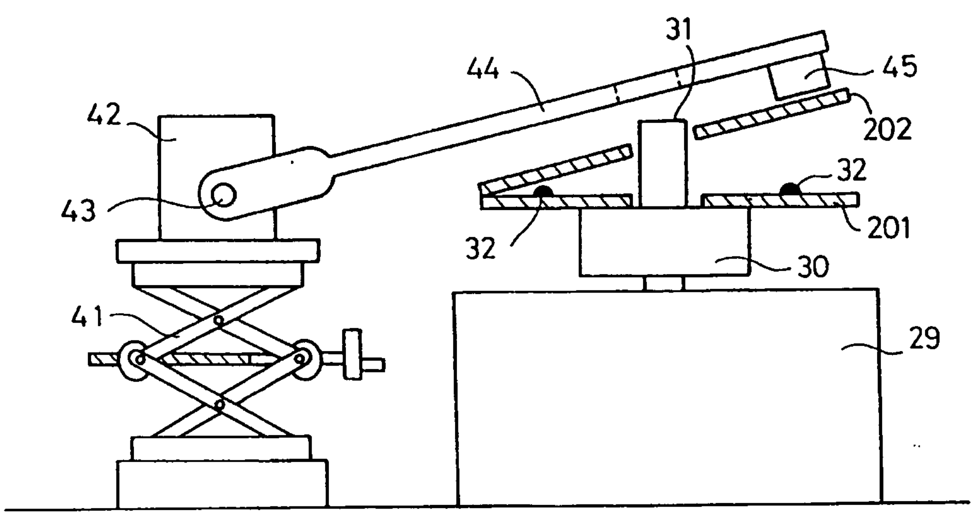

31
44
45
42
202
43
32
201
32
30
41
29

FIG 8